

IN THE CLAIMS:

Please change claims: 1, 6, 9, 11, 15, 16, 18 through 22, 25, and 34 through 40 — all to read as follows.

1 1. (currently amended) Apparatus for printing a desired
2 image on a printing medium, based upon input image data,
3 by construction from individual marks of at least one col-
4 orant, formed in a pixel grid; said apparatus comprising:
5 for each colorant, at least one respective multiele-
6 ment printing array that is subject to mark-intensity er-
7 rors of individual printing elements, including varia-
8 tions in printed intensity as among said elements of the
9 array;
10 means for measuring mark-intensity errors of the at
11 least one array;
12 means for modifying, without entirely replacing, a
13 preexisting multicolumn, multirow numerical tabulation
14 that defines an intensity correspondence between such in-
15 put image data and such marks, to compensate for the
16 measured mark-intensity errors;
17 said modifying means and said modified tabulation
18 comprising means for controlling a halftoning stage or
19 other rendition stage of the printing apparatus;
20 wherein said modifying means comprise means for in-
21 troducing continuous control enabling compensation that
22 is different for different print densities;
23 wherein said halftoning or other rendition stage,
24 prior to final printing preparations and in response to
25 said measuring, enable precise reduction of said inten-
26 sity variations as among said elements; and
27 means for printing using the modified tabulation.

1 2. (previously presented) The apparatus of claim 1,
2 wherein:

3 the apparatus has printing resolution on the order
4 of 450 marks per inch; and

5 the apparatus has mark-positioning addressability on
6 the order of 450 marks per inch, or less.

1 3. (previously presented) The apparatus of claim 2,
2 wherein:

3 the optical-density transformation comprises a ren-
4 dition-thresholding dither matrix.

1 4. (previously presented) The apparatus of claim 2,
2 wherein:

3 the optical-density transformation comprises an
4 error-diffusion thresholding hierarchy.

1 5. (previously presented) The apparatus of claim 2,
2 wherein:
3 the number of individual marking elements in use,
4 divided by the number of rows in the tabulation, equals
5 an integer;
6 the tabulation is one- or two-dimensional only;
7 for at least one of the plurality of multielement
8 printing arrays, the mark-intensity error comprises a re-
9 spective pattern of printing-intensity defects;
10 the measuring means comprise means for measuring the
11 pattern of mark-intensity defects for each multielement
12 printing array respectively; and
13 the modifying means comprising means for applying
14 the respective pattern of defects, for at least one of
15 the multielement printing arrays, to modify a respective
16 said tabulation.

1 6. (currently amended) The apparatus of claim 1, where-
2 in:

3 the means for introducing continuous control, ena-
4 bling precise reduction of variations, comprise means for
5 applying negative feedback based upon measured intensity
6 variations

7
8 ~~for at least one of the plurality of multielement print-~~
9 ~~ing arrays, the colorant deposition error comprises a~~
10 ~~swath-height error; the measuring means comprise means~~
11 ~~for measuring mark intensity error for one or more groups~~
12 ~~of printing elements, each group being fewer than all the~~
13 ~~elements, of each multielement printing array respec-~~
14 ~~tively; and the modifying means comprise means for apply-~~
15 ~~ing the respective mark intensity error, for at least one~~
16 ~~of the multielement printing arrays, to modify a respec-~~
17 ~~tive said tabulation.~~

1 7. (previously presented) The apparatus of claim 1,
2 wherein:

3 the mark-intensity error comprises a pattern of
4 printing-density defects;

5 the measuring means comprise means for measuring the
6 pattern of printing-density defects;

7 the modifying means comprise:

8

9 means for deriving a correction pattern from
10 the measured pattern of printing-density
11 defects, and

12

13 means for applying the correction pattern to
14 modify a halftone thresholding process;
15 and

16

17 for each colorant, the printing means comprise means
18 for printing such image incrementally, using the modified
19 halftone thresholding process.

1 **8. (previously presented) The apparatus of claim 1,**
2 **wherein:**

3 **the measuring means comprise means for measuring**
4 **mark-intensity error for individual printing elements,**
5 **individually, of at least one of the multielement print-**
6 **ing arrays, respectively; and**

7 **the modifying means comprise:**

8

9 **means for deriving a correction pattern from**
10 **the measured mark-intensity error, and**

11

12 **means for applying the correction pattern to**
13 **modify the tabulation.**

1 9. (currently amended) A method of printing a desired
2 image, by construction from individual marks of at least
3 one colorant, formed in a pixel grid by at least one mul-
4 tielelement printing array that is subject to a pattern of
5 printing-density defects, including error in mark inten-
6 sity of individual printing elements, considered individ-
7 ually, including variations in printed intensity as among
8 said elements of the array; said method comprising the
9 steps of:

10 measuring mark-intensity error;

11 deriving a correction pattern from the measured pat-
12 tern of printing-density defects, including error in
13 intensity;

14 applying the intensity-error correction pattern to
15 correct the error, by modifying a halftone thresholding
16 process that uses a halftoning matrix which is a prede-
17 fined numerical tabulation array;

18 wherein the applying step comprises preparing a mod-
19 ified form of the predefined numerical tabulation array,
20 based upon the intensity-error correction pattern, and
21 then using that modified form of the tabulation array;

22 said applying and preparing steps, and said modified
23 form of the numerical tabulation, being used to control
24 the halftoning matrix;

25 wherein said applying and preparing steps further
26 comprise introducing continuous control, enabling compen-
27 sation that is different for different print densities;

28 wherein said continuous control, in response to said
29 measuring, enables precise reduction of said intensity
30 variations as among said elements; and

31 for each said colorant, printing such image by said
32 at least one multielelement array respectively, using the
33 halftone thresholding process modified on the basis of
34 the intensity-error correction pattern.

1 10. (previously presented) The method of claim 9, for
2 use with a printmask in plural-pass printing, said print-
3 mask being a defined system of numerical values, distinct
4 from the measured pattern of defects and distinct from
5 the derived correction pattern, that establishes the
6 printing pass in which each ink mark is to be made; and
7 further comprising the steps of, before or as a part of
8 the applying step:

9 using such printmask to determine a relationship be-
10 tween the halftone matrix and the multielement array; and
11 employing the relationship in the applying step to
12 control application of the correction pattern to the
13 halftone matrix.

1 11. (currently amended) The method of claim 9, wherein:
2 the printing step comprises cooperation between plu-
3 ral printing elements that mark in a single common color,
4 to form marks that together define a single common small
5 region of such image [[.]] in said common color.

1 12. (previously presented) The method of claim 9,
2 wherein:

3 the method comprises no positional-error feedback to
4 modify positional addressing of image data in relation to
5 the pixel grid.

1 13. (original) The method of claim 9, for use with said
2 at least one multielement incremental-printing array that
3 comprises a plurality of multielement printing arrays
4 that print in a corresponding plurality of different col-
5 ors or color dilutions, each multielement printing array
6 being subject to a respective pattern of printing-density
7 defects; and wherein:

8 the measuring, deriving, applying and printing steps
9 are each performed with respect to each multielement
10 printing array respectively.

1 14. (original) The method of claim 13, for use with
2 such plurality of multielement incremental-printing ar-
3 rays that are also each subject to a respective swath-
4 height error; and wherein:

5 the measuring, deriving, applying and printing steps
6 are also employed to modify swath height of at least one
7 of the multielement printing arrays, for accommodating
8 any swath-height error present in each multielement
9 printing array respectively.

1 15. (currently amended) The apparatus method of claim 1
2 [[9]], wherein:

3 the halftoning or other rendition stage thresholding
4 process comprises means defining ~~tion~~ of a halftone
5 matrix.

1 16. (currently amended) The apparatus method of claim 1
2 [[9]], wherein:

3 the halftoning or other rendition stage thresholding
4 process comprises means defining an error-diffusion
5 protocol.

1 17. (original) The method of claim 16, wherein the
2 error-diffusion protocol comprises at least one of:

3 a progressive error-distribution allocation protocol
4 of such error-diffusion halftoning; and

5 a decisional protocol for determining whether to
6 mark a particular pixel.

1 18. (currently amended) The apparatus method of claim 1
2 [[9]], wherein:

3 the halftoning or other rendition stage applying
4 step comprises means for replacing error diffusion or
5 halftoning threshold values above or below a particular
6 value.

1 19. (currently amended) The apparatus method of claim 1
2 [[9]], wherein:

3 the halftoning or other rendition stage applying
4 step comprises means for multiplying error diffusion or
5 halftoning threshold values by a linear factor.

1 20. (currently amended) The apparatus method of claim 1
2 [[9]], wherein:

3 the halftoning or other rendition stage applying
4 step comprises means for applying a gamma correction
5 function to error diffusion or halftoning threshold
6 values.

1 21. (currently amended) The apparatus method of claim 1
2 [[9]], wherein:

3 the halftoning or other rendition stage modifying
4 step comprises a combination of at least two of:
5 means for replacing error diffusion or halftoning
6 threshold values above or below a particular value;
7 means for multiplying each error diffusion or half-
8 toning threshold value by a linear factor; and
9 means for applying a gamma correction function to
10 error diffusion or halftoning threshold values.

1 22. (currently amended) The method of claim 9, wherein:

2 the continuous control comprises application of
3 negative feedback to make the uniformity of marking in-
4 tensity relatively precise as among the individual mark-
5 ing elements

6
7 ~~for each of the plurality of multielement arrays, the~~
8 ~~measuring, deriving and applying steps are each performed~~
9 ~~at most only one time for a full image.~~

1 **23. (currently amended) The method of claim 9, wherein:**
2 **the printing elements have a spacing along the ar-**
3 **ray; and**
4 **the printing step proceeds with a positioning preci-**
5 **sion and addressability that are [[is]] coarser than or**
6 **equal to said printing-element spacing along the array.**

1 **24. (previously presented) The method of claim 9,**
2 **wherein:**
3 **the applying step comprises modifying the average**
4 **number of marks printed by an individual printing element**
5 **whose mark intensity is defective.**

1 25. (currently amended) A method of operating a print-
2 ing apparatus to print a desired image, based on input
3 image data, by construction from individual marks of at
4 least one colorant, formed in a pixel grid by at least
5 one scanning multielement printing array; said printing
6 being subject to error in mark intensity of individual
7 printing elements, considered individually, including va-
8 riations in printed intensity as among said elements of
9 the array; said method comprising the steps of:
10 measuring mark-intensity error;
11 based on the measured mark-intensity error, compen-
12 sating for the intensity error without modifying position
13 of particular marks relative to such pixel grid, or to
14 any ideal form of such pixel grid;
15 said compensating step comprising control of a half-
16 toning stage or other rendition stage of the printing
17 apparatus;
18 wherein compensating corrections in said halftoning
19 or other rendition stage prior to final printing prepara-
20 tions, as negative feedback in response to said measur-
21 ing, enable precise reduction of said intensity varia-
22 tions as among said elements.

1 26. (previously presented) The method of claim 25,
2 wherein:

3 said scanning multielement printing arrays are at
4 least two in number;

5 each printing array forms a pixel grid that is at
6 least partially different from a pixel grid formed by
7 each other printing array, and from any ideal form of
8 such pixel grid; and

9 aside from linear alignment, no step of the method
10 is directed to regularizing the pixel grids to one another
11 or to such ideal form.

1 27. (previously presented) The method of claim 25,
2 wherein:

3 the compensating step comprises the step of adjusting
4 thresholds of a preexisting tabulation that forms a
5 relationship between said input image data and the individual
6 printed marks,

7 said threshold-adjusting step statistically increases
8 or reduces usage of printing elements associated with
9 said mark-intensity error, thereby increasing or decreasing
10 total numbers of marks in image regions associated
11 with those printing elements.

1 28. (previously presented) The method of claim 25,
2 wherein:

3 the measuring step comprises measuring mark-intensity
4 error of printing elements considered as groups,
5 said groups being fewer than all the printing elements
6 for any given color.

29 through 33. (canceled)

1 34. (currently amended) Apparatus for printing a de-
2 sired image on a printing medium, based upon input image
3 data, by construction from individual marks formed in a
4 pixel grid; said apparatus comprising:

5 at least one multielement incremental-printing array
6 that is subject to colorant-deposition error, including
7 error in mark intensity of individual printing elements,
8 considered individually, including variations in printed
9 intensity as among said elements of the array;

10 means for measuring mark-intensity error of the at
11 least one array;

12 means for modifying a multicolumn, multirow numeri-
13 cal tabulation, which forms an intensity relationship be-
14 tween such input image data and such marks, to compensate
15 for the measured mark-intensity error; and

16 means for printing using the modified tabulation;

17 wherein the multielement printing array is an inkjet
18 printhead;

19 said modifying means and said modified tabulation
20 comprising means for controlling a halftoning stage or
21 other rendition stage of the printing apparatus;

22 wherein said modifying means comprise means for in-
23 troducing continuous control enabling compensation that
24 is different for different print densities;

25 wherein said halftoning or other rendition stage,
26 prior to final printing preparations and in response to
27 said measuring, enable precise reduction of said inten-
28 sity variations as among said elements.

1 35. (currently amended) A method of printing a desired
2 image, by construction from individual marks formed in a
3 pixel grid by at least one multielement printing array
4 that is subject to a pattern of printing-density defects,
5 including error in mark intensity of individual printing
6 elements, considered individually, including variations
7 in printed intensity as among said elements of the array;
8 said method comprising the steps of:
9 measuring error in mark intensity;
10 deriving a correction pattern from the measured
11 mark-intensity error;
12 applying the correction pattern to modify a halftone
13 thresholding process that uses a halftoning matrix which
14 is a predefined numerical tabulation array;
15 wherein compensating corrections, in said halftone
16 thresholding process prior to final printing prepara-
17 tions, introduce continuous control enabling compensation
18 that is different for different print densities and ther-
19 eby enabling precise reduction of said intensity varia-
20 tions as among said elements;
21 wherein the applying step comprises preparing a
22 modified form of the predefined numerical tabulation ar-
23 ray, and then using that modified form of the tabulation
24 array, to correct the error in mark intensity; and
25 printing such image using the modified halftone
26 thresholding process;
27 wherein the multielement printing array is an inkjet
28 printhead.

1 36. (currently amended) A method of printing a desired
2 image, based on input image data, by construction from
3 individual marks formed in a pixel grid by at least one
4 scanning multielement printing array; said printing being
5 subject to print-quality defects due to departure of
6 printing-medium advance from an optimum value, and also
7 including error in mark intensity of individual printing
8 elements, considered individually; said method comprising
9 the steps of:

10 measuring a parameter related to such print-quality
11 defects;

12 based on the measured parameter, scaling such input
13 image data with regard to image dimension in the advance
14 direction to compensate for said departure; and

15 printing such image using the scaled input image
16 data;

17 wherein the multielement printing array is an inkjet
18 printhead.

1 37. (currently amended) Apparatus for printing a de-
2 sired image on a printing medium, based upon input image
3 data, by construction from individual marks of at least
4 one colorant, formed in a pixel grid; said apparatus
5 comprising:

6 for each colorant, respective means for printing
7 incrementally in that colorant;

8 each said printing means, for a particular one col-
9 orant, comprising at least one respective incremental-
10 printing array that is subject to colorant-deposition
11 error, including error in mark intensity of individual
12 printing elements, considered individually, including va-
13 riations in printed intensity as among said elements of
14 the array;

15 means for measuring mark intensity error of the at
16 least one array;

17 means for modifying a multicolumn, multirow numeri-
18 cal tabulation that forms an intensity relationship be-
19 tween such input image data and such marks, to compensate
20 for the measured error in mark intensity;

21 wherein the numerical tabulation is not a halftone
22 screen;

23 said modifying means and said modified tabulation
24 being used to control a nonhalftoning rendition stage of
25 the printing apparatus;

26 wherein compensating corrections in said halftoning
27 or other rendition stage prior to final printing prepara-
28 tions, as negative feedback in response to said measur-
29 ing, enable precise reduction of said intensity varia-
30 tions as among said elements; and

31 means for printing using the modified tabulation.

1 38. (currently amended) Apparatus for printing a de-
2 sired image on a printing medium, based upon input image
3 data, by construction from individual marks formed in a
4 pixel grid; said apparatus comprising:

5 at least one multihundred-element printing array
6 that is subject to colorant-deposition error, including
7 error in mark intensity of individual printing elements,
8 considered individually, including variations in printed
9 intensity as among said elements of the array;

10 means for modifying a multicolumn, multirow numeri-
11 cal tabulation that forms an intensity relationship be-
12 tween such input image data and such marks, to compensate
13 for the measured error in mark intensity;

14 said modifying means and said modified tabulation
15 being used to control a halftoning stage or other rendi-
16 tion stage of the printing apparatus;

17 wherein said modifying means comprise means for in-
18 troducing continuous control enabling compensation that
19 is different for different print densities;

20 wherein said halftoning or other rendition stage,
21 prior to final printing preparations and in response to
22 said measuring, enable precise reduction of said inten-
23 sity variations as among said elements; and

24 means for printing using the modified tabulation.

1 39. (currently amended) The apparatus of claim 38,
2 wherein:

3 the means for introducing continuous control com-
4 prise means for applying negative feedback

5

6 apparatus has printing resolution on the order of 450
7 marks per inch; the apparatus has mark-positioning ad-
8 dressability on the order of 450 marks per inch, or less,
9 along at least one axis, whereby the apparatus is incapa-
10 ble of hyperacuity operation; the apparatus further com-
11 pries means for measuring intensity error of the at
12 least one array; and the multihundred-element array has
13 at least three hundred printing elements.

1 40. (currently amended) Apparatus for printing a de-
2 sired image on a printing medium, based upon input image
3 data, by construction from individual marks formed in a
4 pixel grid; said apparatus comprising:

5 at least one multielement incremental printing
6 array, having at least thirty printing elements, that is
7 subject to colorant-deposition error, including error in
8 mark intensity of individual printing elements, consid-
9 ered individually, including variations in printed inten-
10 sity as among said elements of the array;

11 means for measuring intensity error of the at least
12 one array;

13 means for modifying a multicolumn, multirow numeri-
14 cal tabulation, which forms an intensity relationship be-
15 tween such input image data and such marks, to compensate
16 for the measured colorant-deposition error, including
17 error in mark intensity;

18 said modifying means and said modified tabulation
19 being used to control a halftoning stage or other rendi-
20 tion stage of the printing apparatus;

21 wherein compensating corrections in said halftoning
22 or other rendition stage prior to final printing prepara-
23 tions, as negative feedback in response to said measur-
24 ing, enable precise reduction of said intensity varia-
25 tions as among said elements; and

26 means for printing using the modified tabulation.

1 41. (previously presented) The apparatus of claim 40,
2 wherein:

3 the at least one multielement incremental printing
4 array comprises a scanning printhead or a full-page-width
5 printhead.

1 42. (previously presented) The apparatus of claim 40,
2 wherein:

3 the printing means comprise at least one micropro-
4 cessor controlling all of the at least thirty elements
5 simultaneously during printing to select, and selectively
6 actuate, particular elements for printing of particular
7 pixels respectively.